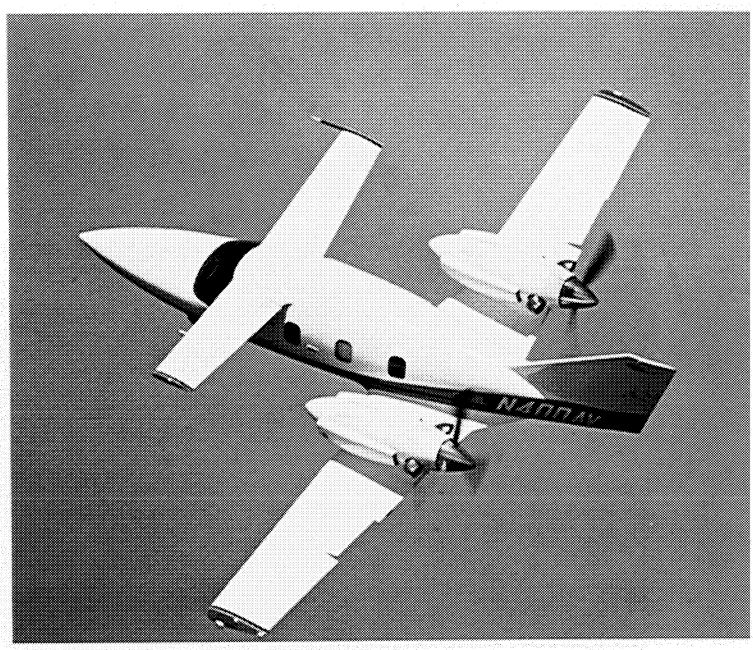
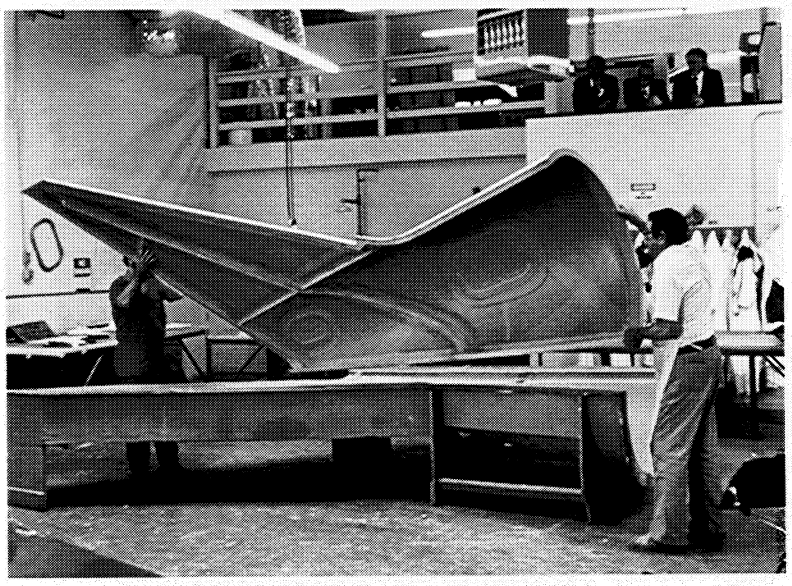
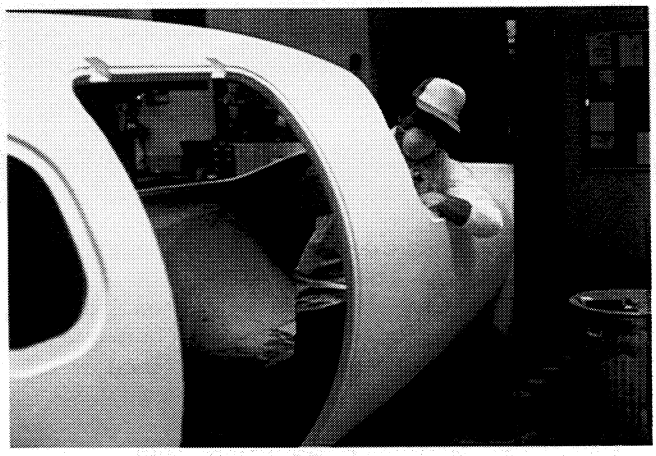
Composite Materials

At right is the Avtek 400 experimental business airplane, a twin turboprop that was introduced to flight test last September. Developed by Avtek Corporation, Camarillo, California, the airplane is distinguished by the fact that its airframe is made entirely of composite materials, which generally are lighter but stronger than the metals they replace.







A number of military and commercial aircraft already in operational service have components made of composites, but the Avtek 400 is among the first all-composite aircraft. Increasing use of composites in airframes is a trend of the future because of the singular advantages they offer in comparison with metal structures: improved performance, dramatically lower weight and, in some cases, reduced cost.

The principal materials used in the Avtek 400 are Kevlar® aramid fiber and Nomex® aramid, both developed by The Du Pont Company, Wilmington, Delaware, a pioneer in development and manufacture of materials for composites. Kevlar is a fiber that, pound for pound, is five times as strong as steel. Nomex is Du Pont's trade name for a family of high strength, high temperature resistant aramid sheet structures, staple fibers and filament yarns. More than 70 percent of the Avtek 400 is made of honeycomb of Nomex sandwiched between skins of Kevlar fiber. Honeycomb is a series of cells grouped together to form a panel similar in appearance to a cross-sectional slice of a beehive. It is 90 to 99 percent open space, hence extremely light; when the core of Nomex is bonded between two surfaces, the resulting sandwich structure has exceptionally high strength-to-weight and rigidity-to-weight ratios.

Use of Kevlar and Nomex in the Avtek 400 combine to give the airplane a light, tough structure that has a maximum weight of only 5,500 pounds, about half the weight of a metal airplane of comparable size and performance. Composites can be molded into many aerodynamic shapes, eliminating most of the rivets and fasteners required in metal construction. The

Avtek 400 is made of 48 molds. The middle photo, opposite page, shows the aft section and vertical stabilizer; at lower left is the forward section.

NASA's Langley Research Center is among the world's leading organizations for research on composite structures. Langley has conducted extensive investigation and test on applying composites to space vehicles, commercial aircraft, military aircraft and helicopters; such work included application testing components of Kevlar that assisted Du Pont in the company's own advancement of its product. Specifically, Langley conducted research in support of Space Shuttle use of pressure bottles filament-wound with Kevlar, a weight saving measure. That development led to use of similar bottles to activate escape slides in the Boeing 747 and 757 jetliners at a saving of 20 pounds per bottle. A Langley/Lockheed Corporation experimental program involving use of composites—including Kevlar—on the L-1011 transport fostered adoption of fiber reinforced parts on such new aircraft as the Boeing 757 and 767, both of which employ significant amounts of hybrid structure composed of Kevlar, carbon and epoxy.

The growing use of composites in aerospace applications is exemplified by Du Pont statistics. In 1983, Du Pont shipments of Kevlar and Nomex to the aerospace industry were used to produce composite parts worth more than $500 million; the company estimates that by 1988 it will be shipping three times as much for aerospace applications alone.

Use of composites is rapidly spreading to other markets—boats, for instance. A large percentage of small pleasure and commercial boats already incorporate composites and the trend is being extended to larger vessels to take advantage of the weight reduction and performance gains composites offer. Shown below is the 80-foot yacht *Kialoa*, whose hull is reinforced with Kevlar fiber; the fiber's toughness increases the hull's resistance to damage and Kevlar's lightness provided new design latitude in distributing weight for maximum sailing efficiency. Du Pont composites are also finding increasing use in such other applications as transportable military shelters, components of automotive vehicles, protective apparel for people in hazardous professions, marine-use ropes and cables, and a broad variety of industrial uses.

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